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Computer Simulation Applied to a Bio-mathematic Model for Tuberculosis

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Abstract

The research will analyze the complex dynamic mathematic model of tuberculosis epidemic and determine its stability property by using the popular Matlab/Simulink software and relative software packages .Facing to the currently TB epidemic situation, in this project we will investgate the development of TB and its developing trend throught constructing the dynamic biomathematics system model of TB.

Keywords: *tuberculosis, Matlab, mathematic;*

1. Introduction

This papers using computer simulation to dynamic model of tuberculosis epidemic situation and progress of research, the World Health Organization (WTO) report, Tuberculosis has emerged as the number one killer disease in humans, human society and pose a serious threat to public health [1], countries due to economic and other reasons, TB control measures and not to the comprehensive promotion and application of some developed countries control measures implemented in the mid-twentieth century, 80 countries because of the neglect of TB control measures to reduce the financial investment, population growth, the increase of floating population, the spread of HIV infection, the slow decline in TB prevalence, and even some countries and regions which had been picked up. Over the past

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few years, more and more researchers to the computer simulation method, combined with the concept of social network study of social phenomena, social issues, such as: spread of the disease, the spread of opinions and the tendency of public opinion ... and so on. Therefore, to promote the study of computer simulation method to establish TB infection model, plan from the tuberculosis complex, social networks and computer simulation to establish disease transmission model in three aspects to illustrate disease through interpersonal social network communication complexity computer simulation method to build the future model to simulate the spread of diseases, there are many suitable and match, and is the main motivation of this study.The Biomathmetics has become the main important trend of research dirction which has applied to the epidemic models of disease mechanism, spreading regulation, and stategy of disease preventing in the field of medical and public health. The papers will apply Lyapunov stability function $V(x)$ to construct a dynamic mathematics models for tuberculosis and to meet the above-mentioned TB disease mechanism, spreading regulation, and stategy of disease preventing in the medical field.

In this paper used Lyapunov stability function is a general rule and method to examine and determine the stability characteristics of a dynamic system. In order to simulate the transmissions of vector-borne diseases and discuss the related health policies effects on vector-borne diseases, we combine the social network, and compartmental model to develop an epidemic simulation model.

The research will analyze the complex dynamic mathematic model of tuberculosis epidemic and determine its stability property by using the popular Matlab/Simulink software and relative software packages. Facing to the currently TB epidemic situation, in this project we will investigate the development of TB and its developing trend thought constructing the dynamic biomathematics system model of TB.

2. Computer Simulation Using Models of Dynamic System for TB

The face of the tuberculosis epidemic, and many biological scientists have established a variety of mathematical reaction dynamics mathematical model of TB, its prevention and control of finding the optimal strategy for prevention and treatment decision-making theory and quantitative basis, in the past through disease transmission model, we can understand the spread of disease phenomena and results, forecast future infection trending and exploring public health policy and medical practice intervention spread of the disease results to public health, disease control personnel and policy makers speaking, the disease transmission model is not but implementation of policy decisions and behavior as the reference basis for quantitative evaluation indicators, more can simulate the real environment will not occur a number of interesting issues. For example: assume cure for a disease not yet come through the disease model, we can cure the effects of pre-simulation. However, the disease simulation is a complex system, need to handle many of the random nature of and uncertainty, often have a lot of information to be collected, compiled, such as: individual, communication network or illness itself to build up a future model more changes need to come back, make the model more consistent with the real status, but also establish an important part of the model. For the simulation of the disease, with a computer simulation method compared to the past in order to simulate the mathematical simulation has more advantages[2]:

- Alarge amount of data processing, data conversion and data presented on a more diverse: for a simulated result, often from each for Observed, when speaking of computer simulation model established, the rest of the collection compared to the results of mathematical simulation is more convenient.
- Mathematical approach to skills can be easily converted to computer-simulated light, otherwise not.

- Computer simulation model for more realistic rendering of the environment directly: Compared to the mathematical symbols, computer simulation can be a square object Type corresponds to the real environment of the individual objects.
- I n the modified terms of more flexibility: As noted above, establishing the model, often according to the actual experimental results or the real conditions for coming back to the adjustment to the computer simulation method of speaking, easy to all information objects of, then If the need to modify or test method than the mathematical formula must be re-written to increase assumptions speaking, more for convenience.

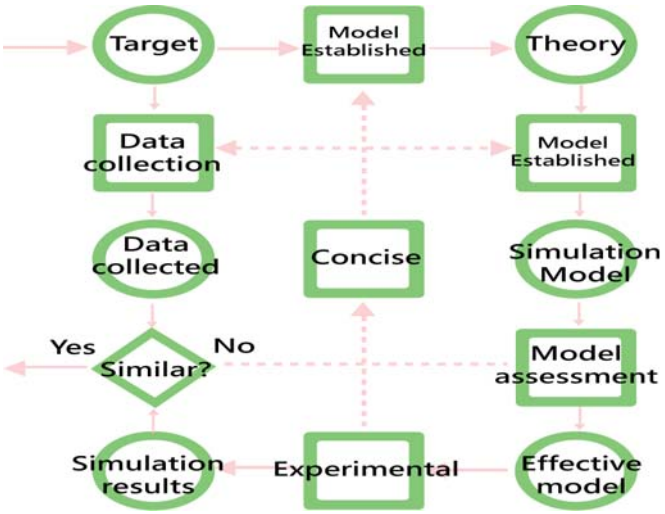

Fig 1.Computer modeling and simulation steps

This papers can be clearly aware of the computer simulation in the build up of dnient platform for understanding the spread of disease, that is what we in this study aims and importance of Lies. The advantages of computer simulation and computer modeling as a traditional mathematical model to simulate the trend of the environment, in addition to more use of computer modeling method can increase the number of random events in a short time, such as an increase in the number of disease models different public health policies, and to simulate different conditions will be the next to see what the result of the difference, so the computer modeling method than the mathematical model can handle more frequent in the real world of complex and random events. In addition, many of the traditional mathematical model is difficult to show the nature of the concept can be simulated in the computer programming skills to use the data structure does not come with that. And most of the mathematical formulas are converted to the concept of conversion to light easily on a computer simulation model, whereas it is not the same simple, so the use of computer modeling to simulate social phenomena in recent years more and more attention[3].

3. Simulation Platform of Bio-mathematic Model Based on MATLAB

A simulation platform of Bio-mathematic dynamics model is developed by using Matlab. The simulation platform can be used in dynamics simulation of epidemic dynamics model， and the

simulation could be used in results analysis. The software is a very powerful numerical simulation software, not only very strong in numerical analysis, the use of its tuberculosis epidemic, the establishment of a variety of reaction dynamics mathematical model of TB, its prevention and control of finding the optimal strategy for the prevention and treatment decision-making Provide theoretical foundation and quantitative basis.

3.1. The combination of computer simulation and software operation Berkeley Modonna.

For execution in the Windows system, widely used in academic and commercial organizations to establish mathematical models as a research and teaching tool. The software is currently the fastest, most convenient tool for solving differential equations, the price is relatively cheap, first we carried out the dynamic equations and parameter setting.

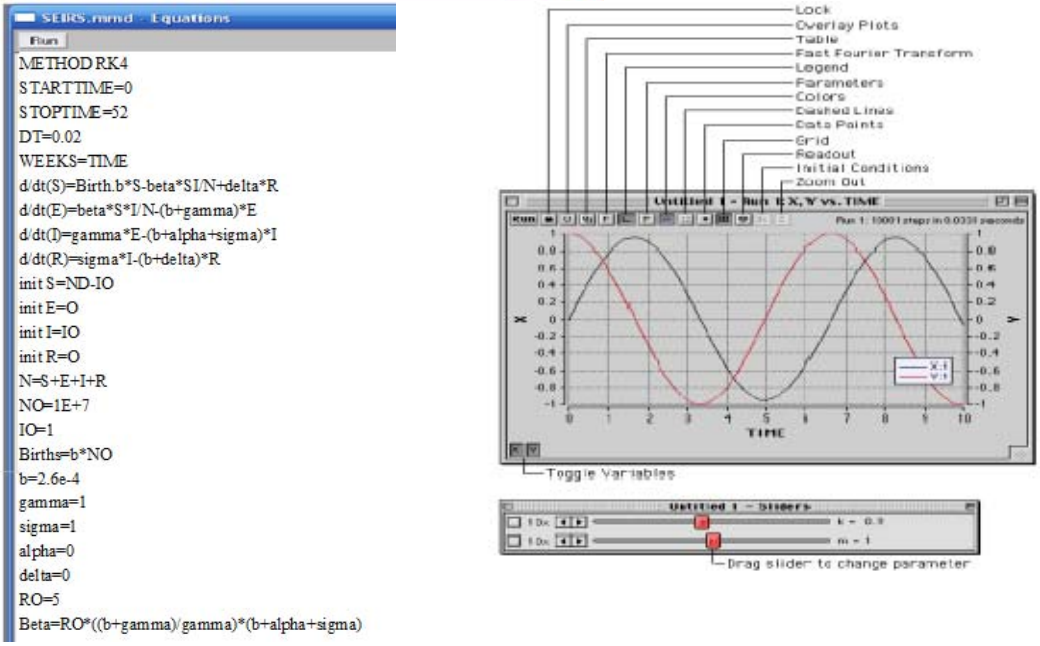

Fig 2 (a) Berkeley Modonna software and parameter settings for the dynamic equation.

(b)The results of differential equations.

After setting, press Run, the system immediately computed results of the differential equations, and draw the Figure 2. diagram types: Size by adjusting the parameters, but also observe the changes in graphics.

3.2. Establishing the basic dynamics of tuberculosis and Mathematics formula.

Based on characteristics of TB disease, the first structure of communication flow chart is as follows:

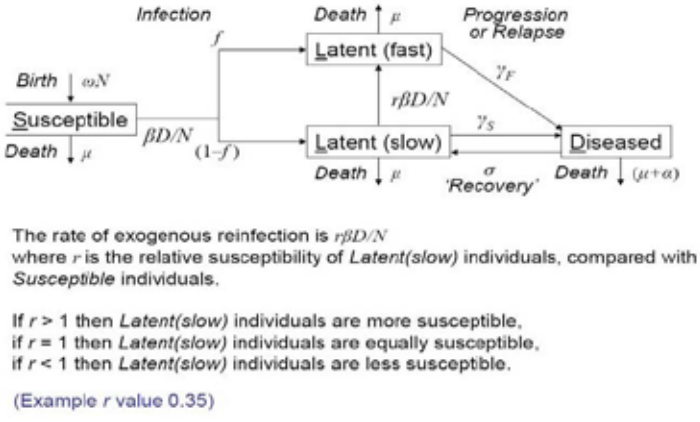

Fig 3. TB flow chart the spread of disease

Significance of the various parameters are as follows:

'Background' death rate (per-capita): μ (1/60 years = 0.0167 p.a.)

Additional death rate due to disease (per-capita): α (0.25 p.a.)

Birth rate (per-capita): ω (to balance background death rate, 0.0167 p.a.)

Infection rate (per capita): *actually a variable, since depends on the number who are infectious at each moment, but includes transmission coefficient parameter* : β

Progression or relapse rate (per-capita): γ (0.12 p.a.)

Recovery rate (per-capita): σ (0.2 p.a.)

Can list out all the dynamic changes in the flow of the equation:

$$\begin{aligned} dS/dt &= \omega N - \mu S - \beta SD/N \\ dL_F/dt &= \beta S(D/N)f + r\beta L_S(D/N) - \mu L_F - \gamma_F L_F \\ dL_S/dt &= \beta S(D/N)(1-f) - r\beta L_S(D/N) - \mu L_S - \gamma_S L_S + \sigma D \\ dD/dt &= \gamma_F L_F + \gamma_S L_S - (\mu+\alpha)D - \sigma D \end{aligned} \tag{1}$$

For some countries or regions, tuberculosis is still very serious. But the impact of various factors of TB development and change it is not very clear. In this case, we need the model from the theoretical research on tuberculosis. Includes a variety of factors in the establishment of more realistic models of TB, through theoretical analysis, data processing, computer simulation to predict the future trend of tuberculosis, in order to find the optimal treatment and control measures to provide some quantitative basis, making the dynamics of infectious diseases In disease prevention and control play a better role [4].

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